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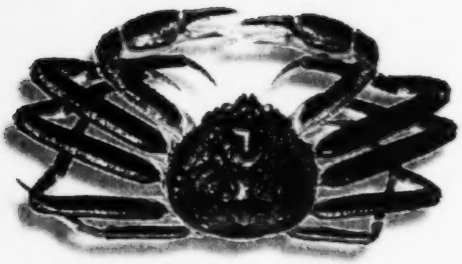
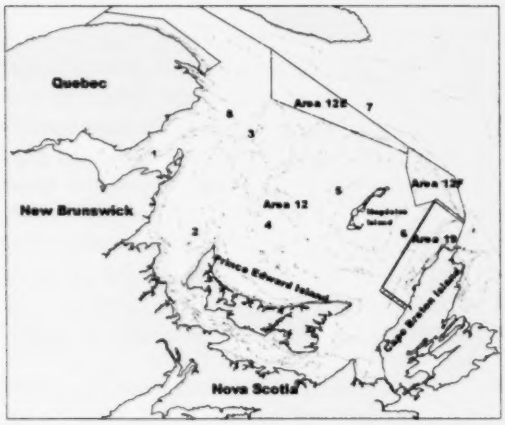
Science | Sciences
Gulf Region
Canadian Science Advisory Secretariat
Science Advisory Report 2010/015

ASSESSMENT OF SNOW CRAB IN THE SOUTHERN GULF OF ST. LAWRENCE (AREAS 12, 19, 12E AND 12F)





1. *Chaleur Bay*
2. *Shediac Valley*
3. *Orphan Bank*
4. *Bradelle Bank*
5. *Magdalen Channel*
6. *Cape Breton Corridor*
7. *Laurentian Channel*
8. *American Bank*

Figure 1: Map of the southern Gulf of St. Lawrence showing the Crab Fishing Areas (CFAs), fishing grounds and management buffer zones (shaded area).

Context:

Snow crab, Chionoecetes opilio, has been commercially exploited in the southern Gulf of St. Lawrence (sGSL) since the mid 1960s. There are four individually managed fishing areas among which Area 12 (Figure 1) is the largest fishery in terms of its fishable surface, number of participants and landings. In Areas 12, 12E and 12F, the fishing season generally starts in April-May as soon as the Gulf is clear of ice and continues into early summer while in Area 19, the fishery opens after June 30 and usually ends in mid-September. The landing of females is prohibited and only hard-shelled males ≥ 95 mm of carapace width are commercially exploited.

This fishery grew quickly from 1966, peaking at 33,400 t in 1982 and dropped to 13,600 t in 1987 and then to the lowest catches level of 8,900 t in 1990. Landings have fluctuated since with peaks in 1995 of 22,750 t and in 2005 of 36,200 t. Landings were 23,642 t in 2009.

DFO Gulf Region Fisheries and Aquaculture Management requested an assessment of the resource status and catch advice for the 2010 fishery. This document is an overview of the assessment results and the advice provided. Catch rates and other fishery performance indicators are reported. The assessment of the status of the southern Gulf snow crab resource (Areas 12, 19, 12E and 12F) is based on fishery independent trawl surveys to develop indicators of : abundance (commercial biomass), reproductive potential (numerical abundance of mature females), recruitment, and to estimate exploitation rates in the fishery. A science peer review was conducted Feb. 22-26, 2010. Participants at the science review included DFO Science, DFO Fisheries and Aquaculture Management, the fishing industry, provincial governments, First Nations communities and an external expert from the US National Marine Fisheries Service.

Canada

SUMMARY

Snow crab in management Areas 12, 19, 12E, and 12F comprise a single biological population and the southern Gulf of St. Lawrence stock is considered as one unit for assessment purposes.

Fishery

Area 12:

- The 2009 landings in Area 12 were 20,896 t (quota of 20,900 t).
- The CPUE decreased since 2007 and is the lowest since 2002.
- The incidence of soft-shelled crab remained low at 5.0%, but locally, Chaleur Bay and 13 other grids were closed during the fishing season.

Area 19:

- The 2009 landings in Area 19 were 2,370 t (quota of 2,433 t).
- The CPUE in 2009 was within the range of values from previous years.
- The incidence of white-crab increased from 10.2% in 2008 to 13.2% in 2009 and all nine sectors within Area 19 were closed during the fishing season.

Area 12E:

- In Area 12E, the landings were 67 t, 33.5% of the 200 t quota.
- The CPUE decreased in 2009 to the lowest value of the time series (1995-2009).
- The incidence of soft-shelled crab in 2009 decreased to 7.8%. Two grids were closed during the fishing season.

Area 12F:

- In Area 12F, landings were 309 t representing 66.5% of the 465 t quota.
- The CPUE decreased in 2009 to the lowest value of the time series (1995-2009).
- The incidence of soft-shelled crab was 11.4%, the highest value since 2000, and eventually all three sectors were closed.

Stock status in the southern Gulf of St. Lawrence

- The 2009 survey biomass of commercial-sized adult crabs was estimated at 26,100 t (23,400 t –29,000 t), 46% lower than in 2008.
- Fifty nine percent (59%) of the 2009 survey biomass, available for the 2010 fishery, is composed of new recruitment (15,500 t). The recruitment to the fishery decreased by 43% relative to 2008.
- The residual biomass (10,700 t) decreased by 48% compared to 2008, and is the second lowest value since 1989.
- The recruitment to the fishery is expected to remain low into 2011. An increase in the abundance of prerecruits (R-3 and R-4) was observed in 2009, which may indicate a potential upward phase in recruitment starting in 2012.
- The abundance of male and female instar VIII (34-44 mm CW) from 2006 to 2009 was 42% lower than that observed during the previous recruitment wave from 1995 to 1999.
- The abundance of mature females has declined since 1990 to the lowest levels during 2006 to 2009.
- The exploitation rate in the southern Gulf of St. Lawrence in 2009 was 50%. Exploitation rate varied between 37% and 53% during 2000 to 2009 compared to between 15% and 31% during 1990 to 1999.

- A risk analysis of catch options relative to reference points for the 2010 fishery is provided. The catch options and associated risk levels (probability of the event happening) are decisions to be made by management and stakeholders.

BACKGROUND

Species Biology

Snow crab (*Chionoecetes opilio*) is a crustacean like lobster and shrimp, with a flat, almost circular, body and five pairs of spider-like legs. The hard outer shell is periodically shed in a process called moulting. After moulting, crabs have a soft shell for a period of 8 to 10 months. Soft-shelled crab is defined by shell hardness (<68 durometer units) and includes both new-soft (condition 1) and clean hard-shelled crab (condition 2). The term white-crab is used in the summer fishery of Area 19 because the newly-molted crabs have reached a relatively harder carapace than those observed during the spring fishery (Areas 12, 12E and 12F). White crab is defined by shell hardness (<78 durometer units) and includes both new soft (condition 1) and clean hard-shelled crab (condition 2).

Unlike lobsters, snow crabs do not continue to moult throughout their lives. Females stop growing when they acquire a wide abdomen for carrying eggs, which occurs at shell widths less than 95mm. Males stop growing when they acquire large claws on the first pair of legs, which can occur at shell widths between 40 and 150 mm. Females produce eggs that are carried beneath the abdomen for approximately 2 years. The eggs hatch in late spring or early summer and the newly-hatched crab larvae spend 12-15 weeks floating freely in the water column. At the end of this period, they settle on the bottom. It takes at least 8-9 years (post-settlement) for males to reach legal size.

Fishery

Until 1994, the snow crab fishery in Area 12 (Figure 1) was exploited by 130 mid-shore fish harvesters from New Brunswick, Québec and Nova Scotia. Since 1997, the PEI coastal fishery, (formerly Areas 25/26) has been integrated into Area 12. In 2003, a portion of the coastal fishery off Cape Breton (formerly Area 18) was also integrated into Area 12. For the purpose of this assessment, Area 12 refers to the new management unit (Figure 1). The number of licenses in Area 12 was 274 in 2009 (Table 1).

In 1978, Area 19 (Figure 1) was established for the exclusive use of Cape Breton inshore fish harvesters with vessels less than 13.7 m (45 feet) in length. There were 167 licenses in Area 19 in 2009.

Areas 12E and 12F were introduced in 1995 as exploratory fisheries. In 2002, the status of Areas 12E and 12F was changed from exploratory to commercial fishing areas. There are 8 and 18 fish harvesters from New Brunswick, Nova Scotia, PEI and Québec in Areas 12E and 12F, respectively.

The minimum legal carapace width is 95 mm, females are not harvested and soft-shell and white crab is not targeted by the fishery. Baited traps, constructed of wire or tubular steel, are used to catch crab, mainly on mud or sand-mud bottoms at temperatures ranging from -0.5 to 4.5°C, and depths ranging from 50 to 280m. The fishery takes place from spring to early summer in Areas 12, 12E and 12F and after June 30 in Area 19.

Management of these fisheries is based on quotas and effort controls (number of licenses, trap allocations, trap dimensions, and seasons) (Table 1). There are soft-shelled and white crab protocols which allow for closure of portions of each fishing area when the proportion of the catch comprised of these exceeds 20%. The protocols are in place to maximize the yield and the reproductive potential of the resource.

Table 1. Number of licenses, boats, traps, quota and opening and closing dates in snow crab fishery by management area in the southern Gulf of St. Lawrence in 2009.

	Area				
	12	12E	12F	19	Southern Gulf
Number of licenses	274	8	18	167	467
Number of boats	370	8	18	104	500
Total traps	39,551	1,200	1,350	1,699	43,800
Opening date	May 02	May 02	April 24	July 15	
Closing date	July 19	July 16	July 03	August 24	
Quota	20,900	200	465	2,433	23,998
Landings	20,896	67	309	2,370	23,642

The landings from the southern Gulf of St. Lawrence increased from 1969 to the present with three periods of high landings: 1981-1986, 1994-1995, and more recently 2002 to 2009 (Figure 2). The peak landing was reported in 2005 (36,118 t) while the lowest landing was reported in 1975 (4,632 t).

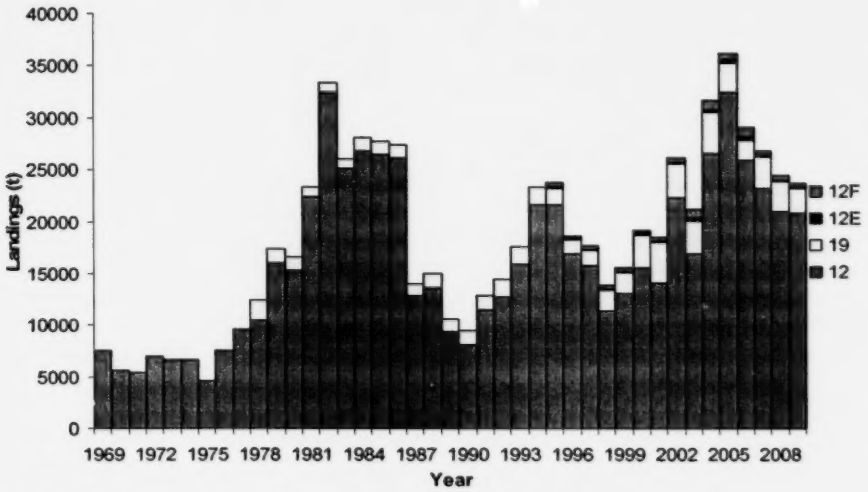


Figure 2: Landings in the southern Gulf of St. Lawrence snow crab fishery.

The 2009 fishing season in Area 12 opened on May 2 and closed on July 19 with reported landings of 20,896 t (quota of 20,900 t) (Tables 1, 2; Figure 2). In accordance with the soft-shelled crab protocol, seventy eight grids were closed during the 2009 fishing season. The fishing effort estimated from logbooks decreased from 508,053 to 370,762 trap hauls from 2005 to 2008 but increased to 433,527 trap hauls in 2009 (Table 2).

Table 2. Quota, landings, fishing effort and catch performance for the snow crab fishery in Area 12.

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Quota (t)	13,819	22,000	17,148	26,600	32,336	25,869	23,207	20,900	20,900
Landings (t)	13,819	21,869	16,898	26,626	32,363	25,889	23,243	20,911	20,896
CPUE (kg/trap-haul)	42.3	40.2	50.0	54.9	63.7	64.4	65.7	56.4	48.2
Effort (trap hauls)	326,382	544,454	337,960	484,991	508,053	402,702	353,775	370,762	433,527
Soft-shelled crab (%) in catches	6.2	4.6	3.3	3.0	3.9	3.1	2.0	3.0	5.0
Grids closed (total of 323)	60	100	0[1]	17	68	11	5	3	78

[1] In 2003, the area was divided into four sectors and none of the sectors were closed.

The 2009 fishing season in Area 19 opened on July 15 and ended on August 24 with reported landings of 2,370 t (quota of 2,433 t) (Tables 1, 3; Figure 2).

In accordance with the white crab protocol, all nine sectors within Area 19 were closed during the 2009 fishing season due to high incidence of white crabs in the catches. The fishing effort in Area 19 decreased from 38,388 trap hauls in 2008 to 33,193 trap hauls in 2009.

Table 3. Quota, landings, fishing effort and catch performance for the snow crab fishery in Area 19.

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Quota (t)	3,912	3,285	3,106	5,092	2,878	2,000	3,074	3,002	2,433
Landings (t)	3,910	3,279	3,103	3,894	2,827	1,989	3,034	2,929	2,370
CPUE (kg/trap-haul)	88.5	72.3	103.6	68.9	68.1	84.4	71.3	76.3	71.4
Effort (trap hauls)	46,251	43,662	29,952	56,517	41,512	23,566	42,553	38,388	33,193
White crab (%) in catches	6.5	3.5	3.7	7.1	9.8	8.3	8.3	10.2	13.2
Sectors closed	0/4	0/4	0/4	4/4	0/4	2/4	0/4	4/4	9/9

The fishing season in Area 12E began on May 2 and ended July 16 with reported landings of 67 t, 33.5% of the 200 t quota (Tables 1, 4; Figure 2). The fishing effort in Area 12E decreased from 9,232 trap hauls in 2008 to 4,653 trap hauls in 2009. In accordance with the soft-shelled protocol, two of eight grids within Area 12E were closed during the 2009 fishing season due to high incidence of soft-shelled crabs in the catch.

Table 4. Quota, landings, fishing effort and catch performance for the snow crab fishery in Area 12E.

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Quota (t)	163	163	350	350	450	550	221	400	200
Landings (t)	155	165	345	349	449	411	220	187	67
CPUE (kg/trap-haul)	23.2	56.6	63.1	55.6	80.6	40.8	37.2	20.3	14.4
Effort (trap hauls)	6,700	2,916	5,471	6,277	5,571	10,074	5,914	9,232	4,653
Soft-shelled crab (%) in catches	0.7	0.3	1.2	1.5	2.9	7.8	1.3	10.1	7.8
Grids closed (total of 8)	0	0	0	0	0	2	0	0	2

In Area 12F, the fishery opened on April 24 and closed on July 3 with reported landings of 309 t representing 66.5% of the 465 t quota (Tables 1, 5; Figure 2). The fishing effort increased from 12,252 trap hauls in 2007 to 15,504 trap hauls in 2008 and decreased to 14,045 trap hauls in

2009. In accordance with the soft-shelled protocol, all three sectors within Area 12F were closed during the 2009 fishing season due to high incidence of soft-shelled crabs in the catch.

Table 5. Quota, landings, fishing effort and catch performance for the snow crab fishery in Area 12F.

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Quota (t)	377	378	808	808	480	815	408	585	465
Landings (t)	378	378	817	806	479	787	370	431	309
CPUE (kg/trap-haul)	63.0	85.2	78.1	74.8	93.7	55.9	30.2	27.8	22.0
Effort (trap hauls)	5,736	4,437	10,460	10,775	5,112	14,079	12,252	15,504	14,045
Soft-shelled crab (%) in catches	1.3	0.5	0.4	0.6	0.8	3.5	2.4	7.3	11.4
Sectors closed (total of 3)	0	0	0	0	0	0	1	3	3

Catch per unit of effort (CPUE kg per trap-haul) is calculated from logbook data. In Area 12, the annual unadjusted mean CPUE (total landings / total effort) decreased from 65.7 kg/th in 2007 to 48.2 kg/th in 2009, the lowest value since 2002 (Table 2; Figure 3). In Area 19, the CPUE decreased in 2009 compared to 2008 (Table 3, Figure 3). The CPUE in Areas 12E and 12F decreased in 2009 to the lowest values since the beginning of the fishery in 1995 (Tables 4, 5; Figure 3).

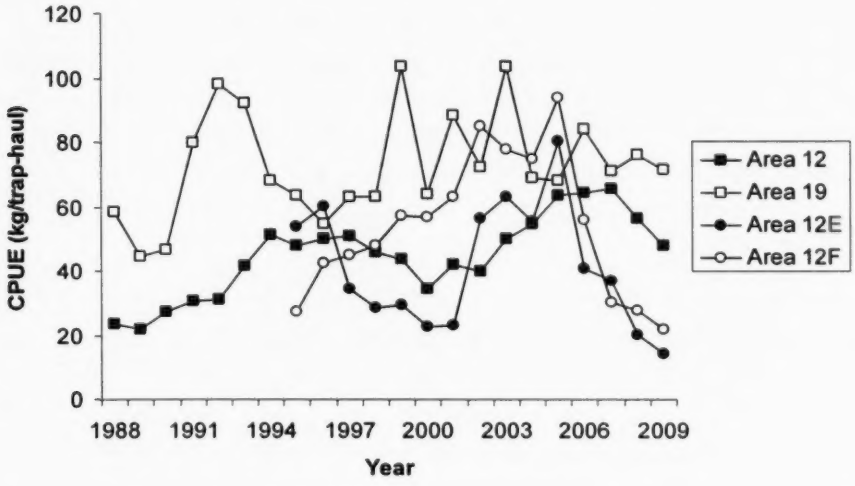


Figure 3: Catch rates in the southern Gulf of St. Lawrence snow crab fishery, Areas 12, 19, 12E and 12F.

The percentage of soft-shelled crabs and white crab is calculated using data collected from the at-sea observer program. The incidence of soft-shelled crab and white crab in catches is strongly influenced by the fishing strategy used by harvesters during the season, as well as crab abundance in the area.

The percentage of soft-shelled crab in Area 12 has remained low since 2001 and was at 5.0% in 2009 (Table 2). In Area 19, the percentage of white crab increased from 10.2% in 2008 to 13.2% in 2009 (Table 3). The percentage of soft-shelled crabs in Area 12E decreased from 10.1% in 2008 to 7.8% in 2009 (Table 4). In Area 12F, the percentage of soft-shelled crabs increased from 7.3% in 2008 to 11.4% in 2009 (Table 5).

ASSESSMENT

Snow crab in management Areas 12, 19, 12E, and 12F comprise a single biological population and the southern Gulf of St. Lawrence stock is considered as one unit for assessment purposes.

Stock Trends and Current Status in the Southern Gulf

Statements of stock status are based on inferences from abundance data from annual trawl surveys conducted during July to September, over the entire area of snow crab distribution in the southern Gulf. This provides estimates of commercial biomass (hard-shelled adult males of legal size remaining after the fishery termed the residual biomass and soft-shelled adult males larger than 95 mm CW (R-1) that will be available to the fishery the following fishing season termed the recruitment) and future male recruitment to the fishery (prerecruits defined as R-4, R-3 and R-2). The prerecruits R-4, R-3 and R-2 represent adolescent male crabs with a carapace width range of 56-68, 69-83, and larger than 83 mm, respectively. A portion of these crabs could be available to the fishery in 4, 3 and 2 years, respectively. The abundances of small adolescent male and female instar VIII (34-44 mm CW) were also estimated as an indicator of long-term recruitment. It takes at least six years for an adolescent male of instar VIII to reach the commercial size of 95 mm CW.

Future and current spawning stock abundance consists of females (pubescent and mature). The term pubescent refers to females that will molt to maturity and mate the following year and become primiparous females (first brood). The term 'multiparous' refers to females which are carrying a brood for the second time or more. The term 'mature females', includes primiparous and multiparous females.

The biomass of commercial-sized adult males from the 2009 trawl survey was estimated at 26,100 t with 95% confidence limits (95% CL) of 23,400 t to 29,000 t, a decrease of 46% compared to the 2008 value (Table 6; Figure 4). The estimated commercial biomass in the southern Gulf has been decreasing since 2004.

The residual (carapace conditions 3 to 5) biomass of commercial sized male crab after the 2009 fishery was 10,700 t (95% CL 9,200 t – 12,300 t), a decrease of 48% compared to 2008 (Table 7; Figure 5). The recruitment to the fishery at the time of the survey was 15,500 t (95% CL 13,300 t – 17,900 t) comprising 59% of the commercial biomass (Table 7; Figure 5). The recruitment decreased by 43% relative to 2008. Commercial biomass as well as recruitment and residual biomass by management areas in the southern Gulf for 2008 and 2009 are provided in Table 7.

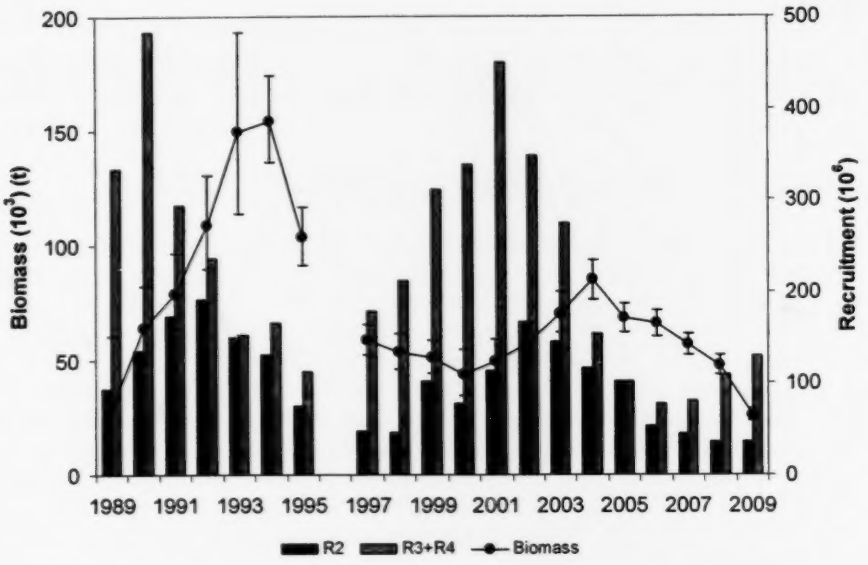


Figure 4: Survey biomass (commercial-sized adult males; mean with 95% confidence intervals) and abundance of future recruitment in the southern Gulf of St. Lawrence.

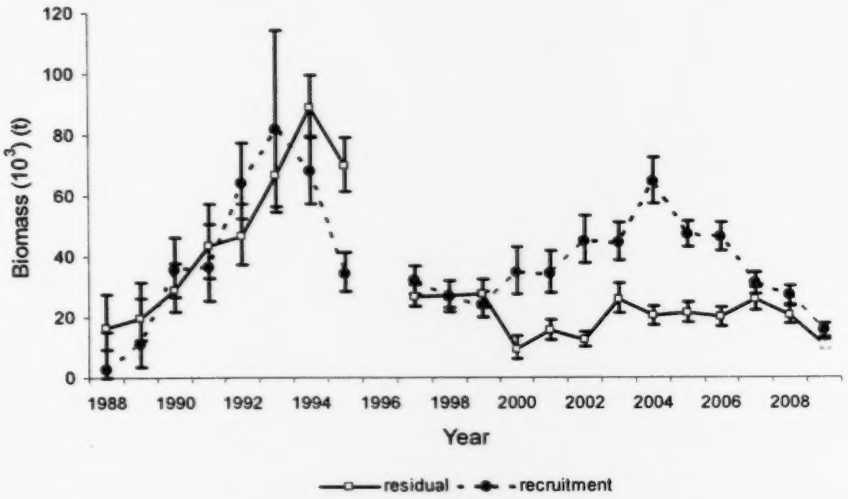


Figure 5: Recruitment (R1) and residual biomass (with 95% confidence intervals) in the southern Gulf of St. Lawrence.

Table 6. Biomass (t; with 95 % confidence intervals) post-fishery of adult commercial sized males (carapace conditions 1, 2, 3, 4 and 5) by management areas and overall in the southern Gulf of St. Lawrence.

Year	southern Gulf	12	19	12E	12F
1988	**18,800** 4,500-52,500	**14,200** 4,300-35,100			
1989	**29,000** 11,600-60,600	**25,100** 13,000-44,100			
1990	**63,900** 48,700-82,300	**42,400** 31,800-55,400			
1991	**78,900** 63,900-96,400	**50,800** 39,400-64,400			
1992	**108,800** 89,800-130,600	**82,700** 68,400-99,100			
1993	**149,700** 114,000-193,000	**126,700** 98,700-160,100	**6,100** 1,600-16,400		
1994	**154,300** 136,000-174,300	**121,900** 107,500-137,600	**7,900** 4,600-12,700		
1995	**103,420** 91,200-116,800	**90,200** 80,800-100,300	**5,000** 2,400-9,200		
1996	**N/A**	**N/A**	**4,100** 3,100-5,200		
1997	**58,600** 52,500-65,200	**49,300** 44,200-54,800	**4,700** 3,700-5,900	**1,500** 640-2,300	**510** 180-850
1998	**53,500** 46,200-61,600	**44,600** 38,500-51,300	**6,000** 4,800-7,500	**3,000** 1,900-4,400	**1,700** 370-5,200
1999	**51,100** 44,300-58,600	**41,500** 36,000-47,600	**5,800** 4,600-7,300	**1,200** 650-2,150	**1,800** 600-4,200
2000	**43,800** 34,600-54,700	**34,200** 26,900-42,900	**7,200** 6,000-8,600	**550** 250-1,100	**2,800** 2,200-3,500
2001	**49,600** 41,300-59,100	**40,600** 34,000-48,200	**6,000** 4,800-7,300	**750** 300-1,600	**3,800** 2,800-5,100
2002	**57,600** 49,300-66,800	**48,400** 41,900-55,700	**5,400** 4,400-6,600	**920** 460-1,700	**3,900** 3,000-5,100
2003	**70,400** 62,000-80,000	**59,400** 52,500-66,900	**8,600** 7,500-9,900	**860** 440-1,500	**3,100** 2,100-4,300
2004	**84,900** 76,500-94,000	**77,300** 70,300-84,900	**4,800** 3,600-6,400	**870** 460-1,500	**2,100** 1,270-3,400
2005	**68,200** 62,300-74,000	**63,000** 57,700-68,600	**3,800** 2,700-5,300	**850** 420-1,500	**1,900** 1,000-3,300
2006	**66,000** 60,400-72,100	**61,900** 56,900-67,200	**4,400** 3,000-6,200	**370** 45-1,400	**560** 75-2,100
2007	**56,800** 52,000-61,800	**50,600** 46,500-55,100	**5,500** 4,300-7,000	**600** 200-1,300	**1,300** 600-2,500
2008	**48,000** 43,800-52,400	**44,700** 41,100-48,600	**3,100** 2,300-4,200	**230** 30-830	**650** 180-1,700
2009	**26,100** 23,400-29,000	**22,100** 19,000-24,700	**3,400** 2,800-4,000	**190** 60-480	**1,190** 750-1,770

In the 2009 trawl survey, snow crab concentrations were located in Chaleur Bay, Bradelle Bank, Shediac Valley, southern and northern parts of the Magdalen Channel and west of Cape Breton Island (Figure 6). The biomass was fragmented spatially relative to distributions observed in the previous six years (Figure 7).

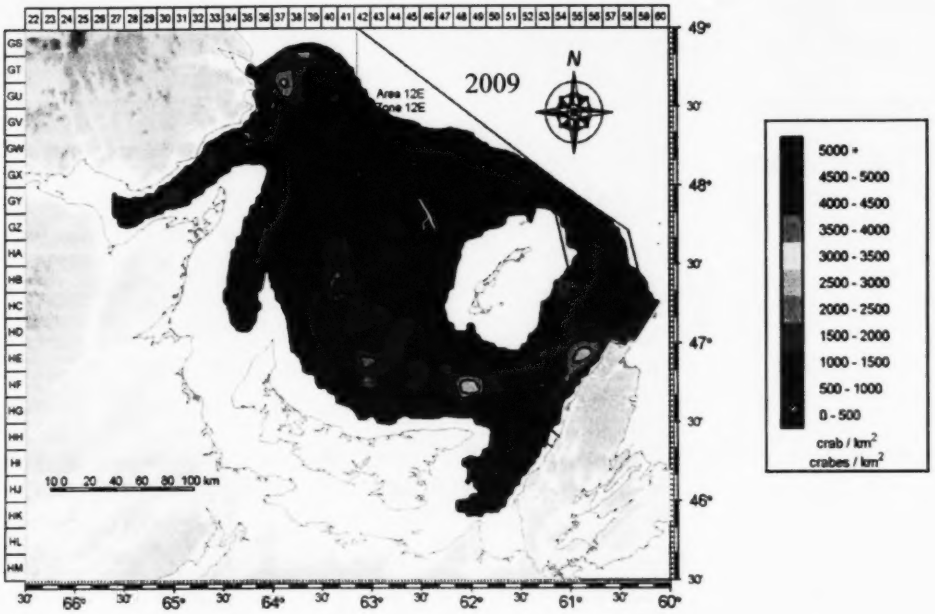


Figure 6: Density (number per km^2) contours of adult male crab ≥95 mm CW in the southern Gulf of St. Lawrence in 2009.

Table 7. Commercial biomass (t; with 95 % confidence intervals), recruitment biomass (t) and residual biomass (t) in the southern Gulf of St. Lawrence and for each management area, in 2008 and 2009.

Area	Year	Commercial biomass	Recruitment biomass	Residual biomass
Southern Gulf	2008	**48,000** 43,800-52,400	**27,100** 24,100-30,300	**20,700** 17,900-23,800
	2009	**26,100** 23,400-29,000	**15,500** 13,300-17,900	**10,700** 9,200-12,300
Area 12	2008	**44,700** 41,100-48,600	**25,500** 22,800-28,400	**18,900** 16,500-21,400
	2009	**22,100** 19,700-24,700	**12,900** 11,000-15,000	**9,300** 7,900-10,700
Area 19	2008	**3,100** 2,300-4,200	**1,600** 1,000-2,400	**1,500** 1,100-2,000
	2009	**3,400** 2,800-4,000	**2,400** 2,000-2,900	**1,000** 700-1,400
Area 12E	2008	**230** 30-830	**40** 0-270	**200** 60-490
	2009	**190** 60-480	**70** 10-300	**120** 40-280
Area 12F	2008	**650** 180-1,670	**410** 90-1,210	**330** 100-820
	2009	**1,190** 750-1,770	**920** 580-1,400	**320** 120-670

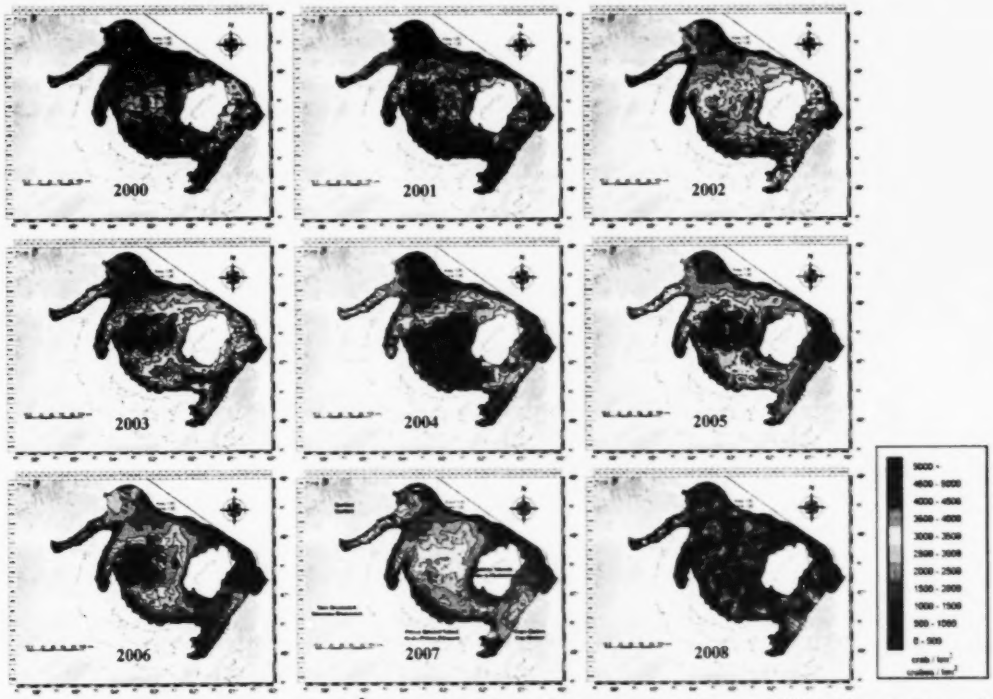


Figure 7: Density (number per km^2) contours of adult male crab ≥95 mm CW in the southern Gulf of St. Lawrence, 2000 to 2008.

The difference between the commercial biomass from the fall survey of 2008 and the residual biomass from the fall survey in 2009, not attributable to fisheries harvests in 2009, was estimated at 22%. The average loss over the time series has been 29%. This loss could be attributed to a number of factors including variability in survey estimates, natural mortality, non-harvest fishing mortalities, and emigration out of the sampled area.

The exploitation rate in the southern Gulf of St. Lawrence in 2009, which is the ratio between the catch of the 2009 fishery and the commercial biomass estimated from the 2008 trawl survey, was 50%. Exploitation rates varied between 37% and 53% during 2000 to 2009 compared to between 15% and 31% during 1990 to 1999 (Figure 8). The total mortality, expressed as a proportion, was estimated at 78% in 2009 (Figure 8). This total mortality varied between 35% and 88% since 1991 (Figure 8).

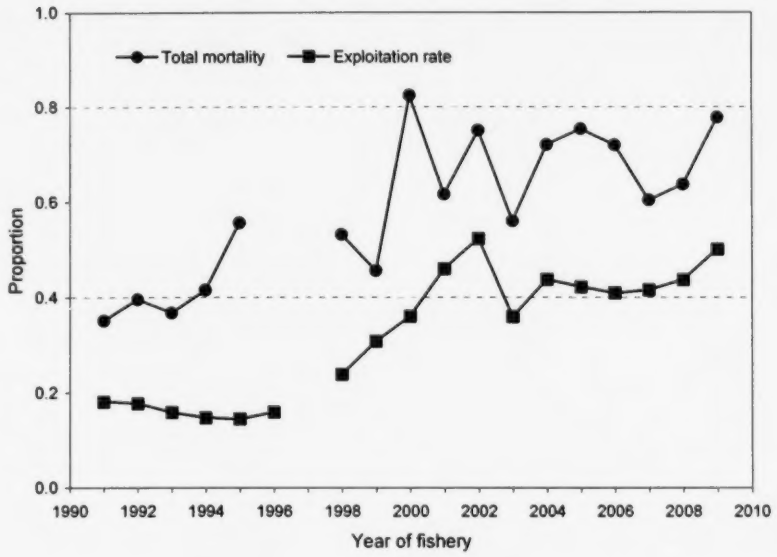


Figure 8: Exploitation rates by the fishery and total mortality of commercial-sized adult male snow crab in the southern Gulf of St. Lawrence, 1990 to 2009.

The recruitment to the fishery in the southern Gulf is expected to remain low in 2011 because of the low abundance of prerecruit males (R-2) observed in the trawl survey in 2009 (Figures 4, 9, 10). The abundance of prerecruits (R-4 and R-3) observed in the 2009 survey, could indicate an upward phase in recruitment to the fishery starting by 2012. The abundances of male and female Instar VIII (34-44 mm CW) observed in the trawl surveys in 2009 have decreased since 2007. The abundance of Instar VIII observed from 2006 to 2009 is 42% lower than the peak observed in the previous recruitment wave from 1995 to 1999 (Figures 11, 12).

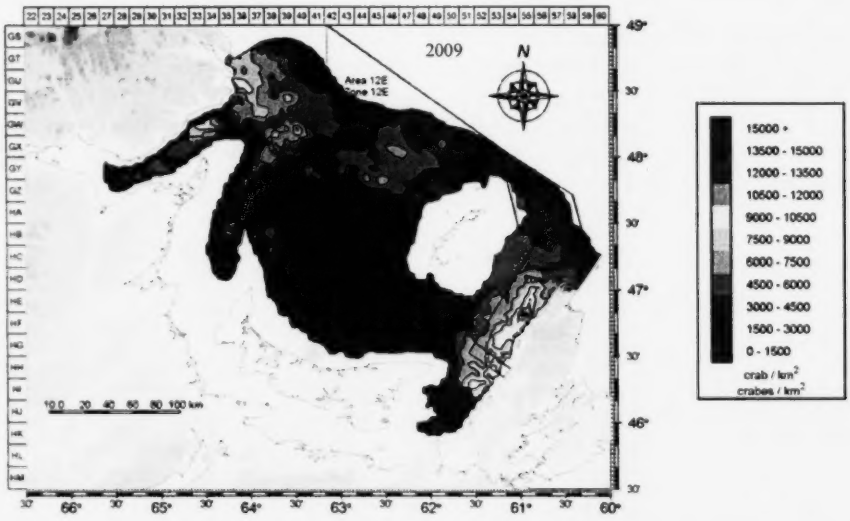


Figure 9: Density (number per km^2) contours of adolescent male crab ≥ 56 mm CW in the southern Gulf of St. Lawrence in 2009.

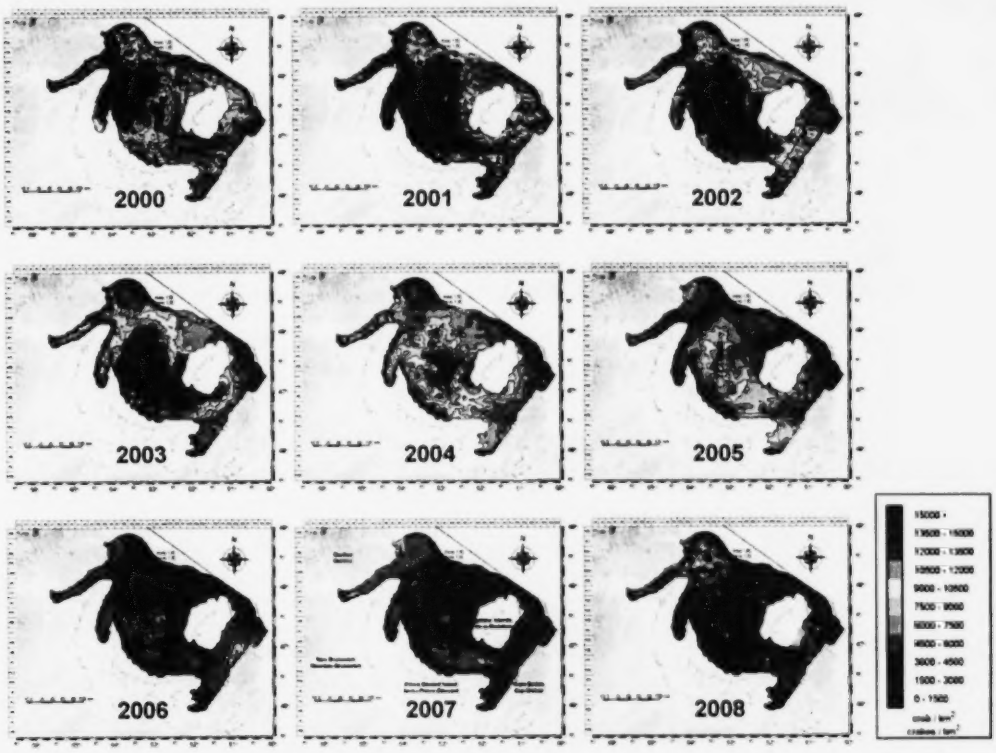


Figure 10: Density (number per km2) contours of adolescent male crab ≥ 56 mm CW in the southern Gulf of St. Lawrence, 2000 to 2008.

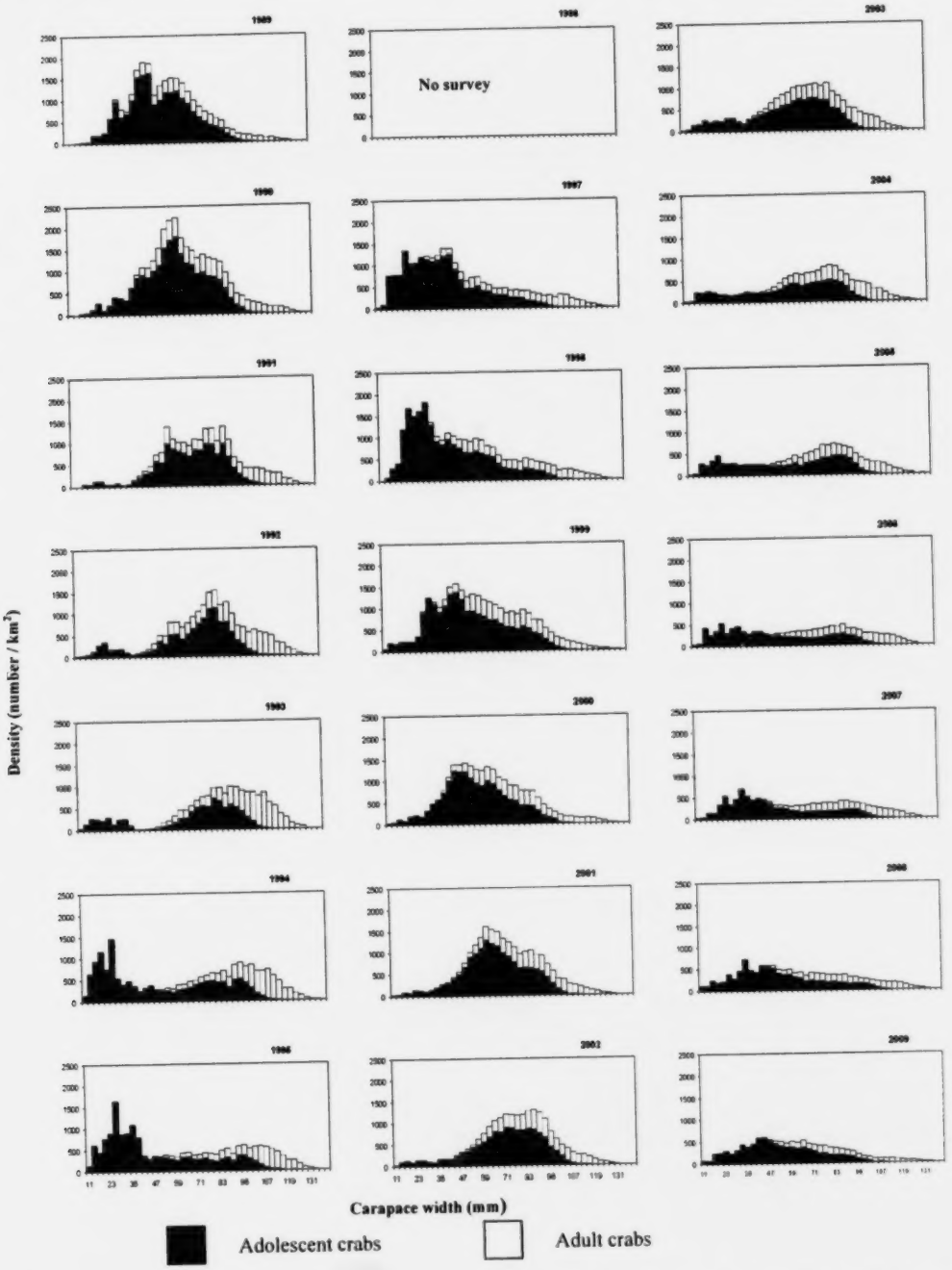


Figure 11: Size frequency distributions of male crab sampled during the trawl survey in the southern Gulf of St. Lawrence after the fishing season.

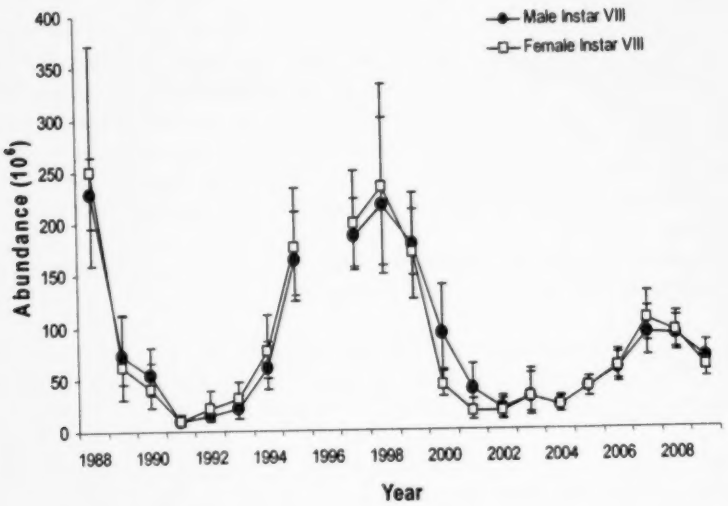


Figure 12: Abundance of males and females Instar VIII, 34 – 44 mm CW, (with 95% confidence intervals) in the southern Gulf of St. Lawrence, 1988 to 2009.

Reproduction

A decrease in the abundance of mature females has been observed since 1990 (Figure 13). The low abundance of immature and pubescent females in the population in recent years indicates that the abundance of mature females will remain lower than the levels during 1999-2002 (Figure 13).

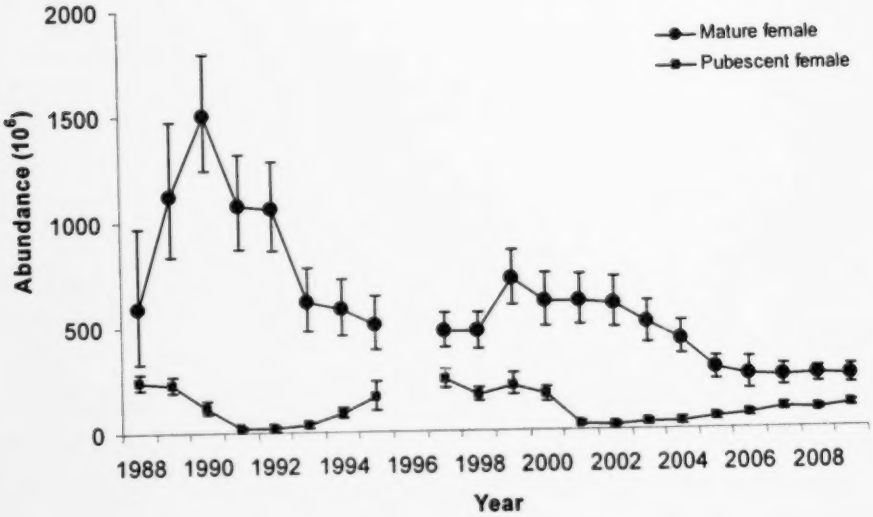


Figure 13: Annual female abundances (with 95% confidence intervals) in the southern Gulf of St. Lawrence based on the trawl surveys.

Sources of Uncertainty

The trawl survey data were processed using the procedure defined in the Assessment Framework Workshop (DFO 2006). A review of the standardization for the tow length, trawl opening width and area of polygon for the time series 1988 to 2006 was reviewed at the 2008 meeting (Moriyasu et al. 2009). But other factors such as the change in vessel cannot be addressed without a comparative survey. It was assumed that the trawl survey biomass estimates for commercial size males are absolute measures of abundance.

Other uncertainties such as growth, natural mortality and movement make it difficult to predict the commercial biomass more than one year in advance.

In the absence of a defined stock-recruitment relationship in this population, there are uncertainties about the future recruitment to the population related to the reduced abundance of mature females in the southern Gulf.

The movement of crabs among the management areas is a major source of uncertainty in the provision of advice for area-specific management.

In 2009, there was a considerable increase in the estimated numbers of landed soft-shelled and white adult commercial-sized crab. These crabs comprised an estimated 13.5% (by numbers) of the landed catch in the southern Gulf of St. Lawrence, which represents 20% of the 2010 recruitment to the fishery for the southern Gulf. This activity affects the projection of recruitment to the fishery based on the abundance of prerecruits R-2 for the risk analysis. Mortality of soft-shelled and white crabs also reduces the yield of the resource and the reproductive potential of the stock.

CONCLUSIONS AND ADVICE

Within the Precautionary Approach (PA) framework (DFO 2009), the Limit Reference Point for biomass (B_{lim}) defines the critical / cautious zones and an Upper Stock Reference (B_{USR}) delimits the cautious / healthy zones on the stock status axis. A Removal Rate Limit Reference Point (F_{lim}) defines the maximum removal rate in the healthy zone. Reference points for the snow crab stock in the southern Gulf of St. Lawrence are: B_{lim} = 9,400 t, B_{USR} = 34,000 t and F_{lim} = 40% (DFO 2010).

The recruitment to the fishery in the southern Gulf is expected to remain low until the 2011 fishery. An increase in the abundance of prerecruits R-4 and R-3 was observed in the 2009 trawl survey which may indicate a potential upward phase in recruitment to the fishery in 2012. However, the abundance of male Instar VIII (future recruitment to the fishery in at least 6 years) observed from 2006 to 2009 is 42% lower than the peak observed in the previous recruitment wave from 1996 to 1999.

Since 2000, this fishery has become largely dependent on the annual recruitment (carapace condition 3) rather than on the residual biomass from one year to the next (Figure 5). The residual biomass since 2003 was maintained between 20,000 and 26,000 t, but declined to 10,700 t in 2009 (Figure 5).

The trajectory of stock abundance (biomass of commercial-sized adult male crab from the fall trawl survey in year t – 1) versus exploitation rate on this biomass in the fishery of year t is shown in Figure 14. Following an increase in biomass from 1990 to 1994, the biomass declined rapidly to low levels by 2000 and has varied between 44,000 t and 85,000 t during 2000 to 2009. Over the period of abundance, exploitation rates have varied between 36% and 50%,

resulting in harvests of 18,500 to 36,100 t. The estimated biomass from the 2009 fall survey, which would be available to the fishery in 2010, was 26,100 t (95% CL range 23,400 t – 29,000 t). The 2009 biomass estimate is in the cautious zone of the PA framework. When the stock is in the cautious zone, the exploitation regime should be defined at a level to favour stock increase toward B_{USR}.

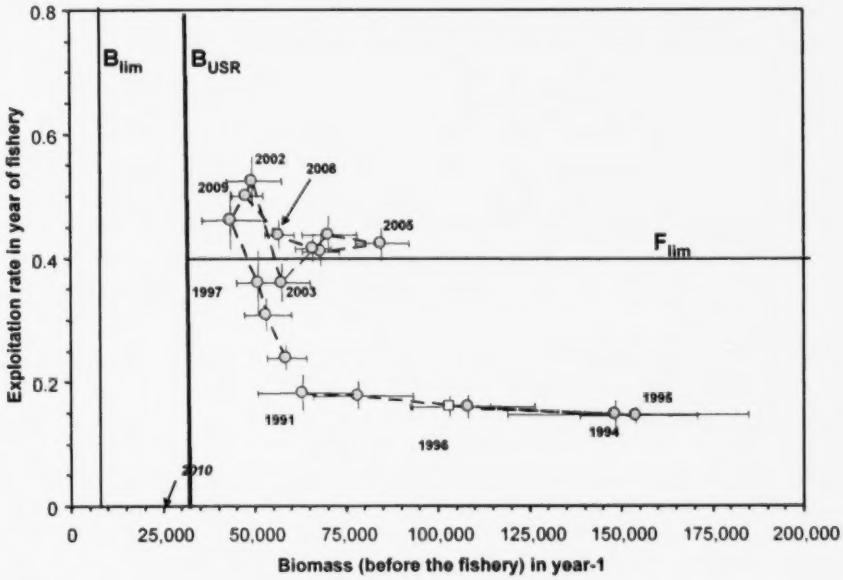


Figure 14: Trajectory of stock abundance (biomass of commercial-sized male crab as estimated from the trawl survey in year t – 1) versus exploitation rate of this biomass in the fishery of year t. Year of the fishery is labeled on the figure. Error bars are 90% confidence interval ranges.

A risk analysis was developed based on the biomass estimated in the 2009 survey relative to various catch options in 2010 (Figures 15 and 16). The catch options and associated risk levels (probability of the event happening) are decisions to be made by management and stakeholders. For example, with a catch option of 11,000 t for the 2010 fishery, there is a 69% chance of exceeding the fishing rate limit reference point (F_{lim}) and a 94% chance of falling below the biomass limit reference point (B_{lim}) (Figure 15). Similarly, with a catch option of 11,000 t, there is a 10% chance of exceeding the biomass upper stock reference (B_{USR}) and a 40% chance that the commercial biomass will decline in 2010 relative to 2009 (Figure 16). Other indicators of stock performance could be examined using the same risk analysis structure.

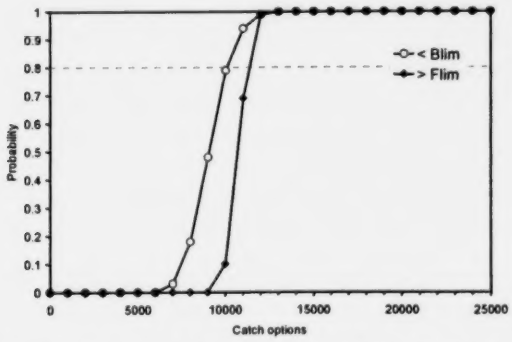


Figure 15: Risk analysis for the southern Gulf of St. Lawrence snow crab fishery showing probabilities of exceeding F_{lim} and of falling below B_{lim} for different catch options in 2010.

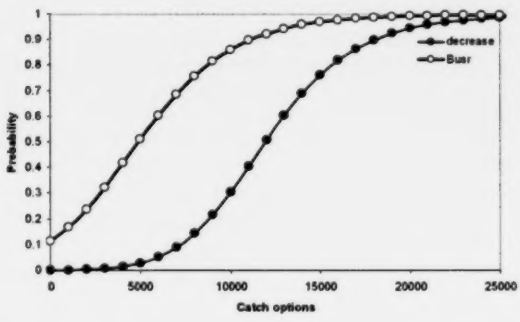


Figure 16: Risk analysis for the southern Gulf of St. Lawrence snow crab fishery showing probabilities of a commercial biomass decrease in 2010 relative to 2009 or that the biomass in 2010 will be below B_{USR} for different catch options in 2010.

OTHER CONSIDERATIONS

Ecosystem Considerations

Environmental factors, such as water temperature, can affect moulting, reproductive dynamics and the movement of snow crab. Bottom temperatures over most of the southern Gulf of St. Lawrence are typically between -1 and 3°C, a temperature range suitable for snow crab. Data collected during research surveys indicate that the bottom temperatures in deeper waters of Areas 12E and 12F are higher (1 to 5°C) than on the crab grounds (-1 to 2°C) in Area 12. Bottom temperatures in Area 19 are usually 1 to 2°C warmer than on the traditional crab grounds in Area 12.

In 2009, near bottom temperatures in the coastal parts of Area 12 and around Prince Edward Island were significantly above normal while the deeper areas of the Magdalen Shallows were around normal. This is a major change from 2008 when most of the deeper parts of the Shallows had negative anomalies of 0 to 1°C. The warmer bottom waters of 2009 resulted in an 9% decrease relative to 2008 in the Gulf-wide snow crab habitat index (bottom area with temperatures from –1 to 3°C) to less than 47,000 km^2, representing the smallest area since 1981 (Figure 17). The mean temperature within the habitat area in 2009 (0.93°C) increased compared to 2008 (0.3°C) by about 0.6°C (Figure 17). In the 39 year data series, the 2009 mean temperature was the 11th highest. The 2009 value is significantly higher than the long term mean and is comparable to the 1999-2002 and 2005-2007 warm periods.

The temperature conditions are considered to be less favorable for snow crab because the mean core-index temperature is higher than normal and the habitat extent is lower (Figure 17). However, how these changes influence the distribution and abundance of snow crab is unknown.

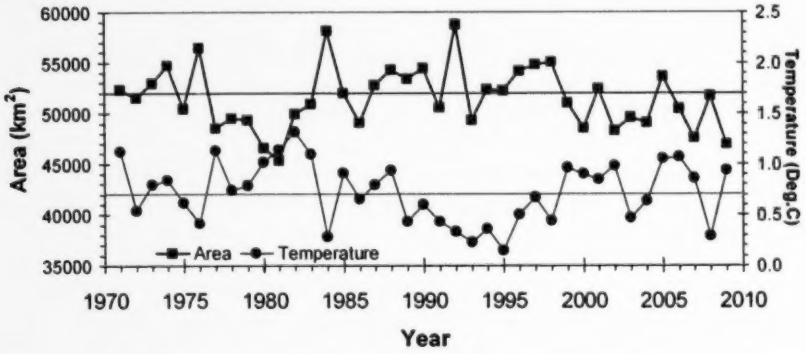


Figure 17: Snow crab habitat area index and mean temperature index in the southern Gulf of St. Lawrence.

Soft-shelled and white crab protocols

There are soft-shelled and white crab protocols in the management areas of the southern Gulf of St. Lawrence. The objective of the protocols is to protect the recruitment which has less commercial value to the current fishery but will contribute to reproduction and to yield to the following year's fishery. The protocol used since 2000 in Area 12 leads to grid or sector closure when the average percentage of soft-shelled crab exceeds 20% (in numbers) for a 15-day period. The analyses of the performance of the current Area 12 soft-shelled crab protocol employed since 2000 revealed that this protocol efficiently reduced the capture of these crabs during the fishery (Figure 18). This protocol differs from the one used from 1990 to 1999 where the whole fishery could be closed when the incidence of soft-shelled crabs exceeded 20% in number for two consecutive weeks. As a new wave of recruitment to the fishery is expected in the coming years, a soft-shelled and white crab protocol is a good management tool to protect the recruits in order to maximize the future yield and reproductive potential of the stock. A statistical examination is ongoing to provide refinements to the protocols.

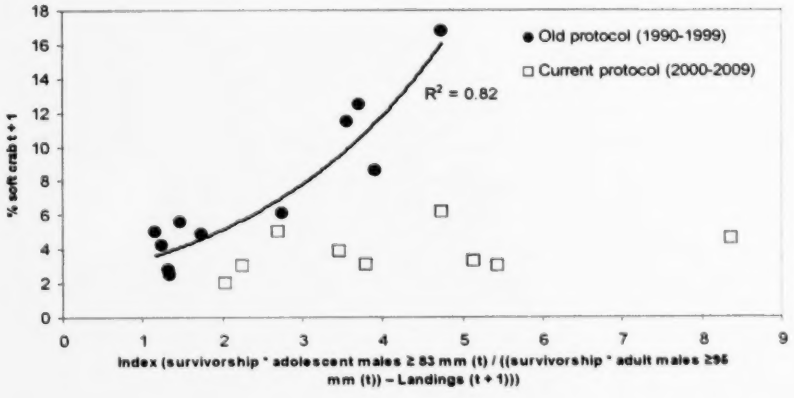


Figure 18: Relative performance of the soft-shelled crab protocol used in Area 12 (closure of grids) since 2000 and the protocol used from 1990 to 1999 (closure of the whole area).

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